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Phagocata suginoi sp. nov., a New Probably
Subterranean Freshwater Planarian from
the Hokuriku District in Honshû*

With 7 Text-figures

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ABSTRACT A new species of the genus *Phagocata* (Turbellaria, Tricladida, Paludicola), *Phagocata suginoi* Kawakatsu, sp. nov., from the Hokuriku district in Honshû, Japan, is described in the present paper. This new species, probably a subterranean inhabitant, is unique in its long, extraordinarily wide and thick-walled common ovovitelline duct among the species of the genus.

On January 23, 1973, a number of specimens of small-sized freshwater planarian were discovered by Mr. Masanori Inomata, a member of the "Biology Club of Kashiwazaki Agricultural High School" (chief: Murayama), from a spring at Soji, Kashiwazaki, Niigata Prefecture (see the photographic article printed in the "Niigata-Nippô" for September 20, 1973). This locality is located at the foot of low hills in a city on the Sea of Japan (the Hokuriku district in the Chûbu Region, Honshû; see map of Fig. 7). Murayama, who succeeded in collecting about 25 specimens of the animal in the field on the same day, examined them to find that the animal is very similar in appearance to *Phagocata kawakatsui* Okugawa, 1956. About a half of the specimens collected were preserved in Bouin's fluid. They were sent to Kawakatsu for identification, with a sketch of the head of the animal.

After examination of a series of sections of these specimens (stained with

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Delafield's haematoxylin and eosin; Kawakatsu's Specimen Lot No. 1248 group), it was at once demonstrated that anatomy of the genital apparatus of this animal does not correspond to that of *Phagocata kawakatsui*. Kawakatsu has come to the conclusion that the present form is a hitherto undescribed new species of the genus *Phagocata*. At Kawakatsu's request, Murayama recollected a sufficient number of additional specimens of this new species in January, 1974, and took many color photographs of living specimens. Nimura, who collected specimens of *Phagocata kawakatsui* from the Matsumoto locality (cf. Kawakatsu and Iwaki, 1967), cooperated with Murayama in examining live specimens of *Ph. kawakatsui* and of the present new species. Their data were immediately reported to Kawakatsu.

In the present paper, this new triclad turbellarian from Japan is described by the senior author, together with some remarks about the ecology observed by the junior authors. The authors take pleasure in naming this new species after Dr. Hisao Sugino, Professor Emeritus of Ōsaka Kyōiku University, in honor of his invaluable contributions to the morphogenesis of triclad turbellarians.

Order TRICLADIDA

Suborder PALUDICOLA or PROBURSALIA

Family Planariidae

Genus *Phagocata* LEIDY, 1847

Phagocata suginoi Kawakatsu, spec. nov.

[Japanese name: Hokuriku-hoso-uzumushi]

Description. A small, delicate, and slightly pigmented species. General appearance of living, fully mature specimens is as shown in photographs in Fig. 1 (A and B). According to the observations made by the junior authors, living, sexually mature specimens are whitish gray to pale grayish brown in color, about 6 to 8 mm long and 0.8 to 1 mm wide. In life the head has a subtruncated form. Usually, the center of the anterior margin of the head slightly protrudes and the anterolateral corner is slightly projecting, but round (which represents the less-developed auricles). Behind the head, the body gradually widens, reaching its greatest width at the middle part of the body. Then, the body narrows again to form a slightly pointed posterior end.

There are two very small eyes situated close together and farther from the frontal margin than from the lateral margins; the distance between them is about one-fifth the width of the head at the level of eyes (Figs. 1 A-C, 2 A and B). No pigment-free ocular areas are found around each eye (one of the distinguishing features of the present new species from *Phagocata kawakatsui*).

The pharynx is inserted at about the middle of the body and is nearly one-fifth as long as the body. The copulatory organs occupy the anterior one-third of the

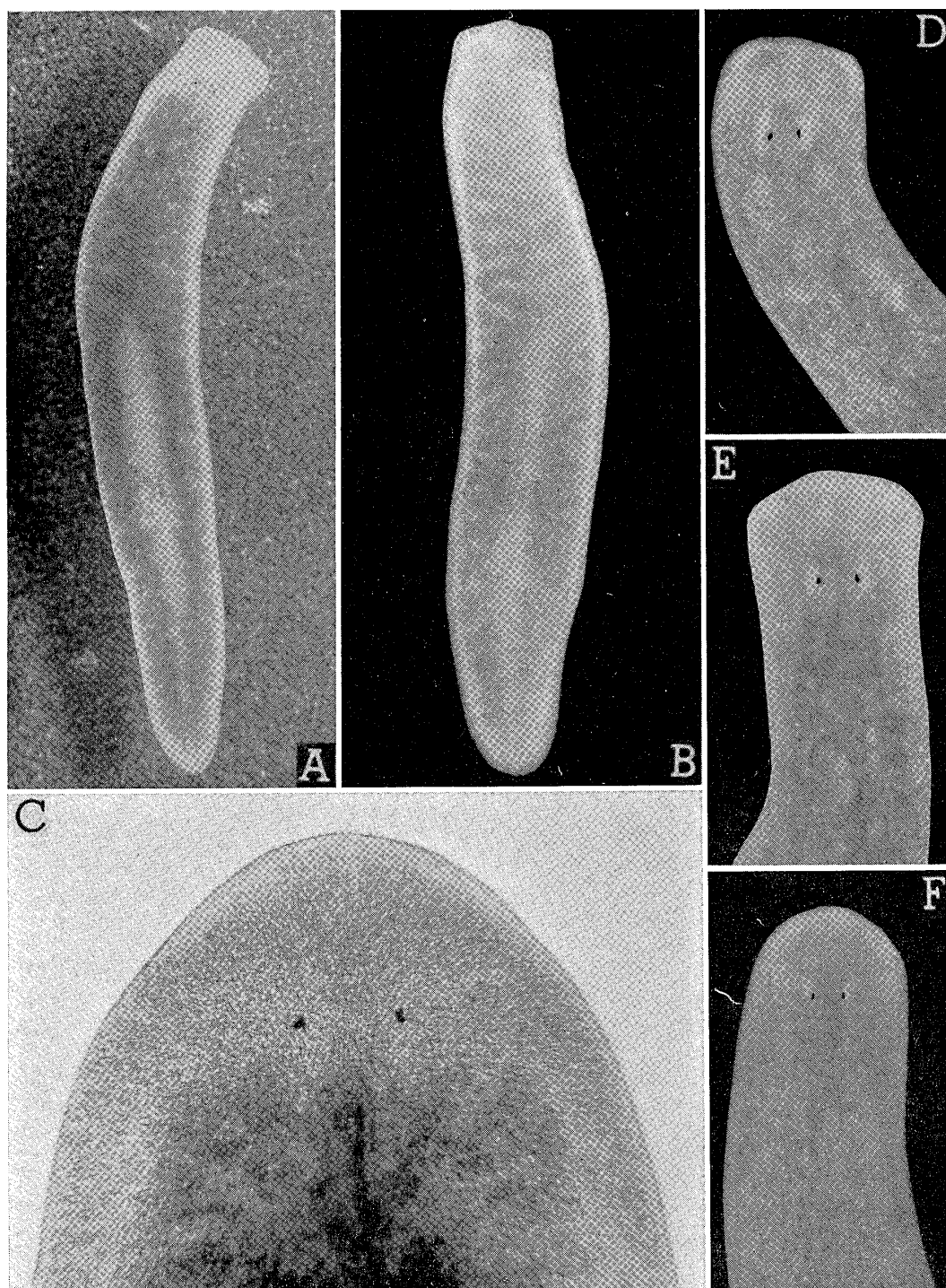


Fig. 1. A and B: Two living sexually mature specimens of *Phagocata suginoi* spec. nov. (photographs by Murayama). C: Head of a preserved specimen of *Phagocata suginoi* spec. nov. (Specimen No. 1252 a; photograph by Kawakatsu). D: Head of a living specimen of *Phagocata kawakatsui* Okugawa, 1956, from the Takamatsu locality (photograph by Kawakatsu). E: Head of a living specimen of *Phagocata teshirogii* Ichikawa et Kawakatsu, 1962, from the Hirosaki locality (photograph by Dr. Teshirogi). F: Head of a living specimen of *Phagocata iwamai* Ichikawa et Kawakatsu, 1962, from the Nayoro locality (photograph by Kawakatsu).

postpharyngeal region (Figs. 1 A and B, 2 A and B). The genital pore opens at about the anterior one-third level of the postpharyngeal region (Fig. 2 A and B). In the present new species, the pharynx and the copulatory apparatus usually have a whitish color. The head and the margins of the body are white or somewhat translucent. The ventral side of the body is largely whitish hue. The external characters described above (especially, the shape of head) have a great resemblance to those of the three Japanese *Phagocata* species (*kawakatsui*, *teshirogii* and *iwamai*). Externally, the present new species can easily be distinguished from the other forms by a delicate body and its low pigmented coloration, by the shape of head, and by the small eyes and their position (see Fig. 1 D-F). In the preserved condition, the animal of the present new species can be separable externally from the other *Phagocata* species by the low pigmentation of body and the appearance of small eyes.

The twelve fully grown specimens were sectioned sagittally, transversely and horizontally. In histological sections the marginal adhesive zone is well-developed in the present new species. The pharynx is structurally typical of the genus *Phagocata* and of the family Planariidae. In mature worms the anterior intestinal trunk bears 8 to 10 branches on each side. Each posterior trunk has 13 to 15 or more short lateral branches (Fig. 2 A).

Photomicrographs of the parts of the genital organs including the copulatory apparatus of several specimens of the present new species are shown in Figs. 3 (A and B), 4 (A-H) and 5 (A-D). Figure 6 shows a sagittal view of the copulatory apparatus (Specimen No. 1248 d; holotype).

A pair of rather large ovaries are situated in the usual ventral space between the first and the second intestinal diverticula (Figs. 2 B, 3 B). The two ovovitelline ducts converge in the region of the penis bulb and open separately into the terminal part of the expanded common ovovitelline duct (or the glandular cavity of the female genital antrum) (Figs. 4 G, 5 D, 6). Numerous yolk glands (or vitellaria) are distributed throughout the body in the surrounding parenchyma (Fig. 3 A and B).

The testes are numerous, middle-sized, and occupy almost all the entire dorso-ventral diameter of the parenchyma of the body. They are arranged on either side of the midline in two to three longitudinal zones extending immediately from the posterior level of the ovaries nearly to the posterior end of the body. Behind the level of the genital pore, many small testes are also found in the space between the two posterior intestinal trunks (Figs. 2 B, 3 A and B). On examination of the sagittal, transversal and horizontal sections, their total number can be estimated at almost 100 or more. In the present new species the sperm ducts form highly developed spermiducal vesicles packed with sperm on either side of the posterior part of the pharyngeal region (Figs. 2 B, 4 B, 5 A). At the level of the mouth, each spermiducal vesicle ascends vertically, then narrows to a slender duct, and curves postero-ventrally; it curves anteriorly and inwardly through the penis bulb, as shown in Fig. 6, and finally opens into the bulbar cavity separately from the dorsal side (see also Fig. 4 C).

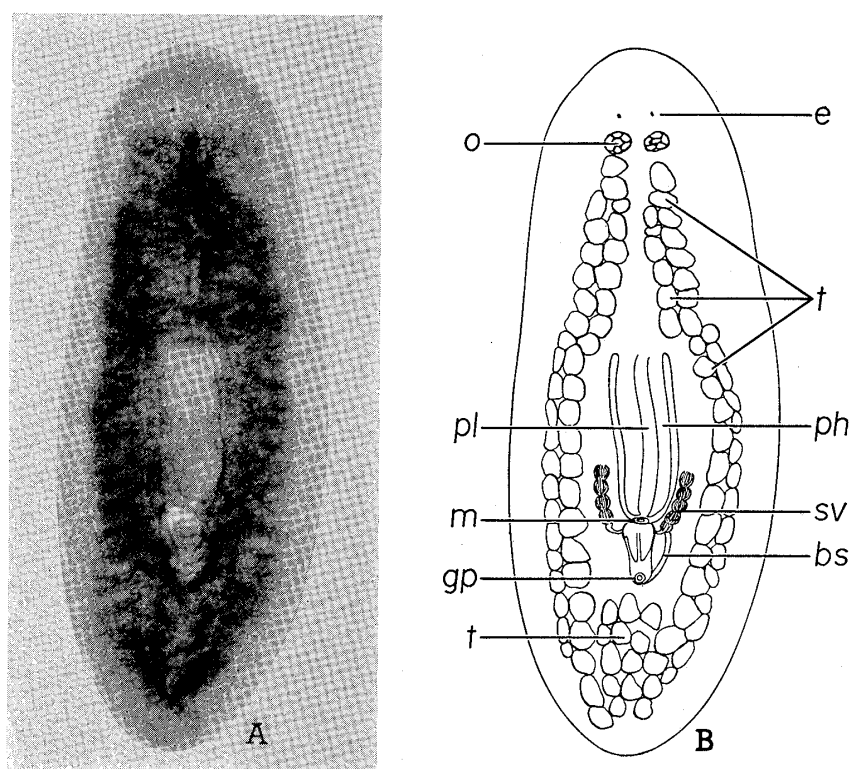


Fig. 2. General view of a mature specimen of *Phagocata suginoi* spec. nov. (Specimen No. 1252 a). A: Photograph taken from a whole mount. Note the digestive system. B: Sketch of the same specimen. Note the arrangement of testes.
bs, bursa stalk; e, eye; gp, genital pore; m, mouth; o, ovary; ph, pharynx; pl, pharynx lumen; sv, spermiducal vesicle; t, testis.

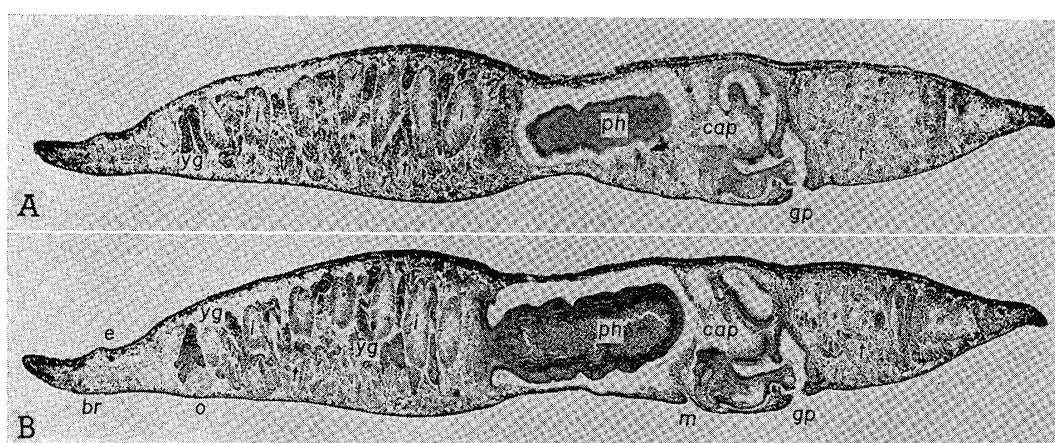


Fig. 3. *Phagocata suginoi* spec. nov. (Specimen No. 1248 b). A: Near mid-sagittal section. B: Near mid-sagittal section (more median than that of A).
br, brain; cap, copulatory apparatus; e, eye; gp, genital pore; i, intestine; m, mouth; ph, pharynx; o, ovary; t, testis; yg, yolk gland.

Regarding the course of the sperm duct described above, some differences were observed probably due to the state of contraction of the pharynx and copulatory apparatus when the animal was killed. Typically, the sperm duct is very long in the present new species (Fig. 6).

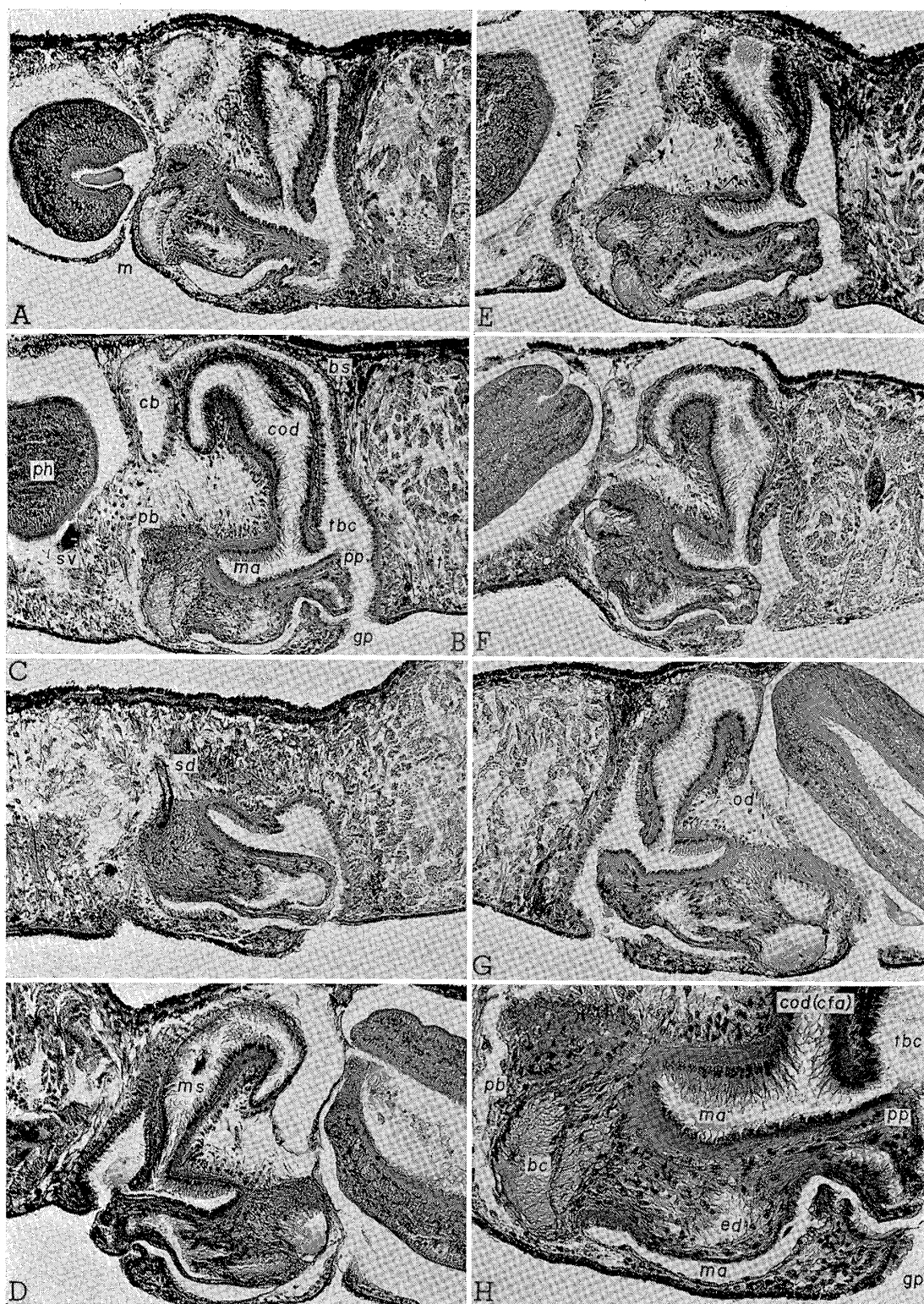
The anterior part of the copulatory apparatus of the specimen shown in Fig. 6 is slightly contracted by the pressure of the pharynx; the penis papilla is rather elongated (see also Fig. 4 D). The genital pore leads immediately into a wide terminal part of the bursal canal dorsally and into the male genital antrum anteriorly. The wall of the male genital antrum is covered with a tall, glandular epithelium, below which occur two layers of muscles, the outer circular fibers and the inner longitudinal ones (Fig. 4 H). The glandular epithelium of a floor of the male genital antrum is thinner than the other part. The epithelial cells are of a nucleate type.

The penis has a middle-sized, spherical bulb embedded in the parenchyma and a large and long papilla of a cylindrical shape projecting into the male genital antrum (Figs. 4 A–H, 6). Both the bulb and the papilla are not highly muscular in nature. The bulb contains a rather wide, ovoidal-shaped cavity in a slightly irregular outline, the bulbar cavity or the seminal vesicle. It continues to the papilla as a long, wide, and curved cavity which represents an ejaculatory duct; it opens at the tip of the papilla. An isthmus separates the bulbar cavity from the ejaculatory duct. The roof of a middle part of the ejaculatory duct has a protuberance with indented outline (Fig. 6). The penis lumen is mostly lined by a thick, highly glandular epithelium of a nucleate type. The glandular epithelial cells are less-developed at the floor of the ejaculatory duct. The penis bulb is pierced by many gland ducts (penis gland) which open into the bulbar cavity as well as the roof of the ejaculatory duct. The outer wall of the penis papilla is covered with a cubical epithelium of a nucleate type (Fig. 4 H). It is much thicker on the dorsal side than the ventral. Below the epithelium there are two layers of muscle fibres, one circular and the other longitudinal.

The most peculiar feature in the genital anatomy of the present new species is a structure of the thick-walled and expanded common ovovitelline duct or the glandular cavity of the female genital antrum (Figs. 3 A and B, 4 A, B, D, E, F and G, 5 C and D). As shown in Fig. 6, it is an extraordinarily wide, long, and strongly curved cavity which opens into the roof of a posterior part of the male genital antrum. The lumen is lined with a very tall, highly glandular epithelium of a nucleate type (Fig. 5 C and D). Its epithelial cells contain heavily eosinophilous granules. The

Fig. 4. Photomicrographs showing the copulatory apparatus of *Phagocata suginoi* spec. nov. All the sagittal sections (Specimen Lot No. 1248 group). A: No. 1248 a. B: No. 1248 b. C: No. 1248 c. D: No. 1248 d (holotype). E: No. 1248 e. F: 1248 i. G: No. 1248 j. H: No. 1248 b (enlarged).

bc, bulbar cavity; bs, bursa stalk; cb, copulatory bursa; cod (cfa), common ovovitelline duct or the glandular cavity of the female genital antrum; ed, ejaculatory duct; gp, genital pore; m, mouth; ma, male antrum; pb, penis bulb; ph, pharynx; pp, penis papilla; sd, sperm duct; sv, spermiducal vesicle; t, testis; tbc, terminal part of the bursal canal.



cell bodies of many eosinophilous gland ducts are distributed in the surrounding parenchyma of the expanded common ovovitelline duct, the muscular coat of which consists of three layers of muscle fibres, i. e., a thin layer of longitudinal, a rather wide layer of circular, and a thin layer of longitudinal muscle fibers (Figs. 5 C and D, 6). In some slides examined, a mass of sperms was found in the cavity of the common ovovitelline duct (Fig. 4 D).

The copulatory bursa is a middle-sized organ and is an elongated oval in shape with somewhat irregularly lobed outline (Figs. 4 A, B, E and F, 6). It is situated in a narrow dorsal space between the anterior end of the copulatory apparatus and the posterior end of the pharyngeal chamber. The lumen of the bursa is lined with a tall glandular epithelium. The bursa stalk is a very long and slender duct, which runs posteriorly and then curves ventrally to reach the genital pore (Figs. 4 B, 5 C, 6). The terminal part of the bursal canal is expanded and lined by a tall, thicker epithelium than the middle and anterior parts of the canal (Figs. 4 A, B, D, E and G, 5 B, 6). The epithelial cells are of a nucleate type (Fig. 5 B). The entire bursa stalk has a thin muscular coat consisting of an inner circular and an outer longitudinal ones. There is no development of a common genital antrum as the terminal part of the bursal canal joins the male genital antrum close to the genital pore (Fig. 6). Weakly eosinophilous cement glands can be seen near the genital pore.

The cocoon of the present new species is not known.

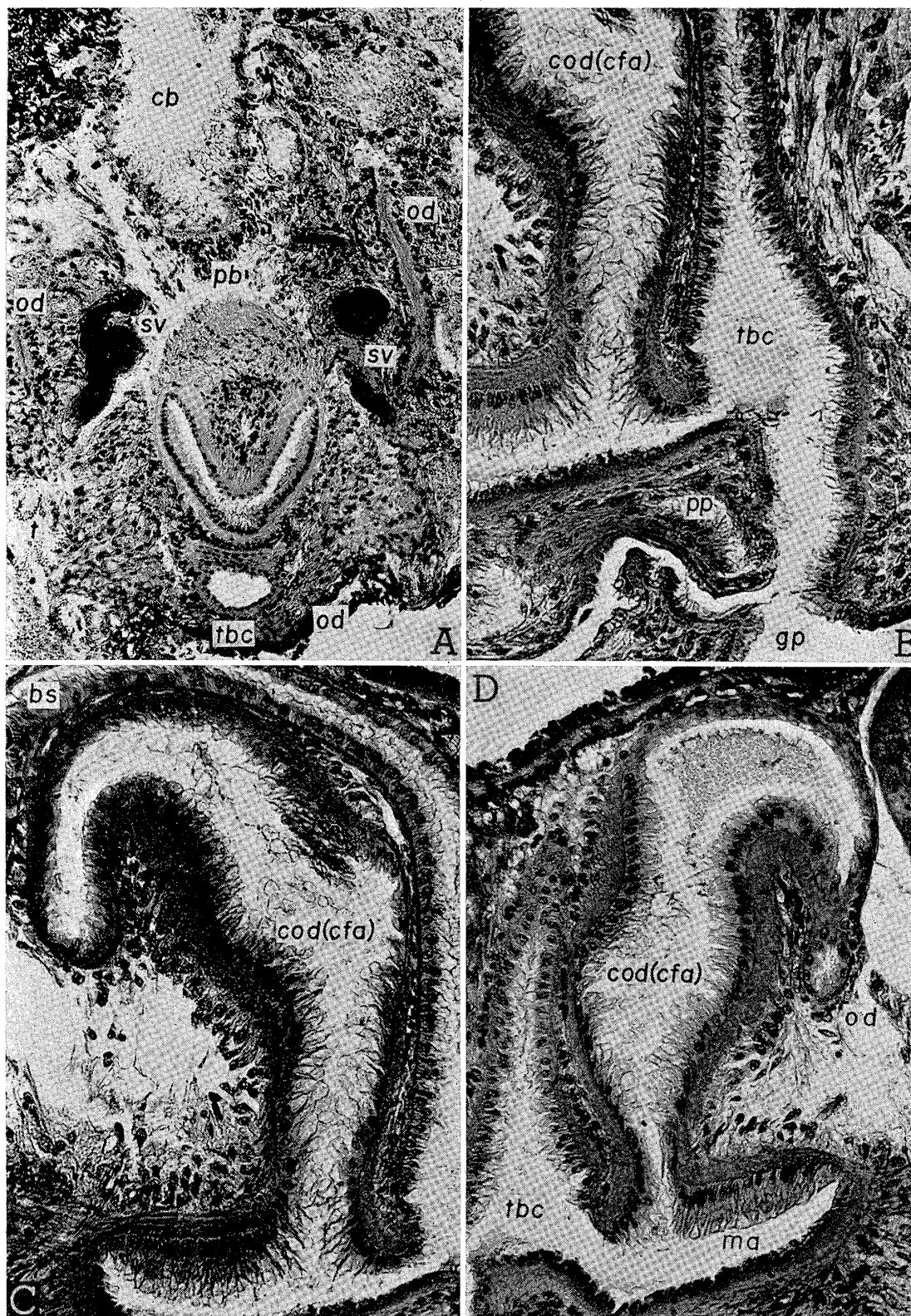
Holotype. One set of sagittal serial sections (Specimen No. 1248 d; two slides) will be deposited in the Department of Zoology, the National Science Museum, Tokyo. Three paratypes also will be deposited in the same Museum (No. 1248 b, sagittal sections; No. 1248 k, horizontal sections; No. 1252 a, whole mount). The remaining paratypes including preserved specimens in alcohol are retained by the senior author (Kawakatsu's laboratory, Fuji Women's College, Sapporo).

Locality. A spring at Soji, Kashiwazaki Niigata Prefecture, Honshû (the Hokuriku district in the Chûbu Region). Altitude, about 80 m. Collected by H. Murayama on January 23, 1973. Additional specimens were collected several times by the same collector.

Taxonomic remarks and differential diagnosis. The known species of the genus *Phagocata* (*sensu* Hyman, 1937, 1951; Kenk, 1970, 1972 a, b) from the Far East including the Japanese Islands were listed and discussed taxonomically and choro-

Fig. 5. Photomicrographs showing the parts of the copulatory apparatus of *Phagocata suginoi* spec. nov. A: Horizontal section of the copulatory apparatus (Specimen No. 1248 k). B: Sagittal section of the posterior part of the copulatory apparatus (Specimen No. 1248 b). C: Sagittal section through the common ovovitelline duct (Specimen No. 1248 b). D: Sagittal section through the common ovovitelline duct (Specimen No. 1248 j).

bs, bursa stalk; cb, copulatory bursa; cod (cfa), common ovovitelline duct or the glandular cavity of the female genital antrum; gp, genital pore; ma, male antrum; od, ovovitelline duct; pb, penis bulb; pp, penis papilla; sv, spermiducal vesicle; t, testis; tbc, terminal part of the bursal canal.



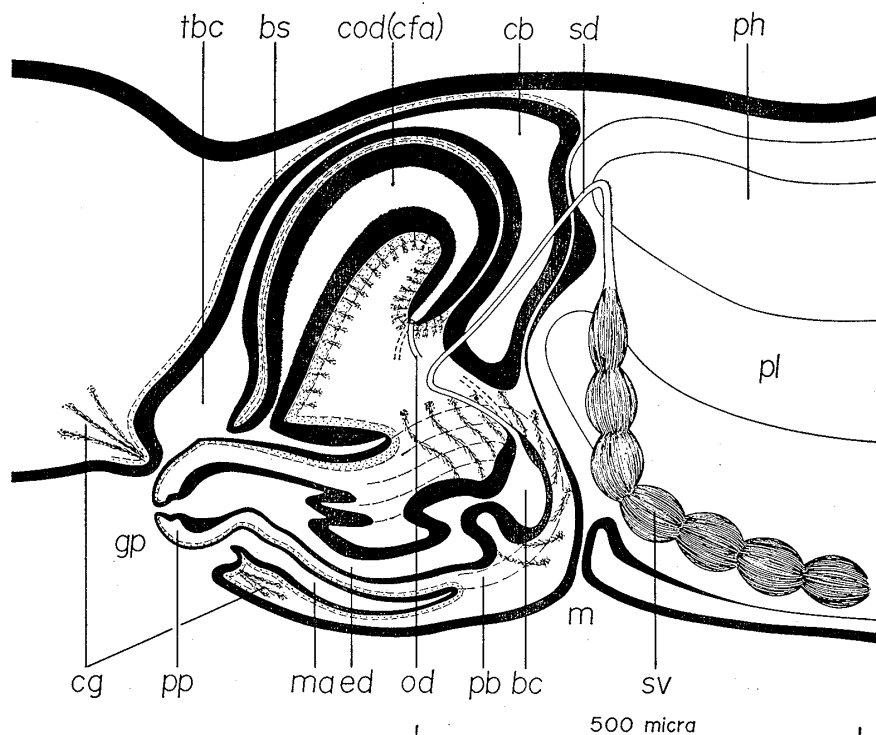


Fig. 6. Diagram showing the sagittal view of the copulatory apparatus of *Phagocata suginoi* spec. nov. (Specimen No. 1248 d, holotype).

bc, bulbar cavity; bs, bursa stalk; cb, copulatory bursa; cg, cement gland; cod (cfa), common ovovitelline duct or the glandular cavity of the female genital antrum; ed, ejaculatory duct; gp, genital pore; m, mouth; ma, male antrum; od, ovovitelline duct; pb, penis bulb; ph, pharynx; pl, pharynx lumen; pp, penis papilla; sd, sperm duct; sv, spermiducal vesicle; tbc, terminal part of the bursal canal.

logically in some previous literature (cf. Ichikawa and Kawakatsu, 1962 a, b, c, 1963; Kawakatsu, 1965, 1966, 1967, 1968 b, 1969, 1973, 1974, and others; Okugawa, 1939, 1953, 1956). The list and discussion of the *Phagocata* species from Central Asiatic countries, Europe, Algeria in North Africa, and North America will be found in the following papers. They are: Ball (1969), de Beauchamp (1958 and others), Dahm (1949, 1964), Hyman (1951 and others), Kawakatsu (1968 a), Kenk (1953, 1970, 1972 a, b, and others), and Livanow and Zabusova (1940). Thus, the genus has about 45 or more species which spread in the Northern Hemisphere (Lat. 30°N. to 65°N; cf. Kawakatsu, 1968 c, p. 17, fig. III-5).

Among the *Phagocata* species including several undescribed forms reported from Japan (cf. Kawakatsu, 1969, p. 47, table 1), the present new species, *Phagocata suginoi*, can be easily separable by the low pigmentation of the body and the shape of the head with a pair of small eyes. Only one Japanese subterranean species, *Phagocata papillifera* (Ijima et Kaburaki, 1916), is a low-pigmented form with two small eyes. This species is hitherto known only from a well in Tokyo (type-locality) and from shallow wells in Mitsukaidô near Tokyo (cf. Kawakatsu, 1969; Kawakatsu

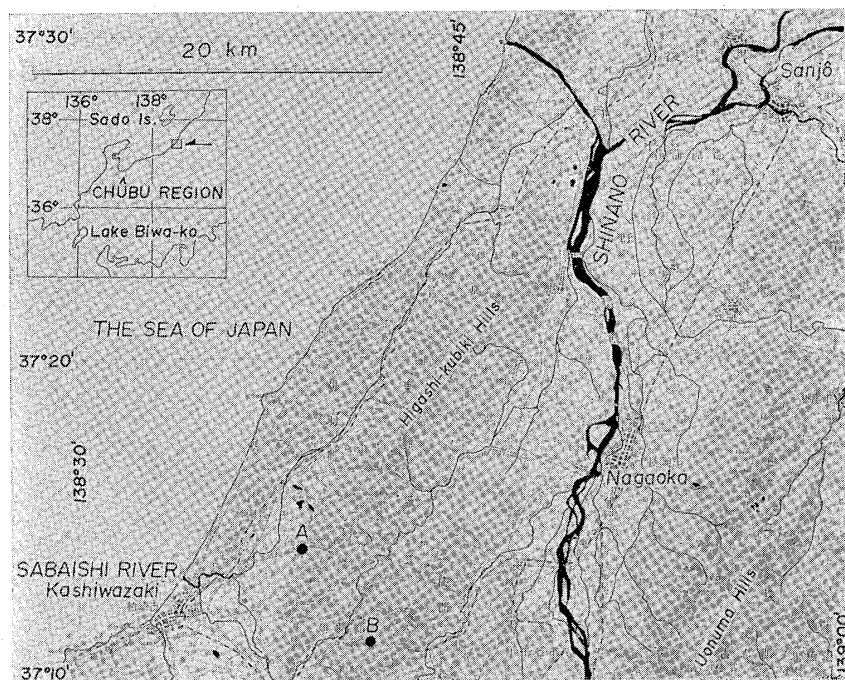


Fig. 7. Map of the middle-western part of the Niigata Prefecture (vicinities of Kashiwazaki), Honshû, showing the type-locality of *Phagocata suginoi* spec. nov. (A, Soji) and the locality of *Phagocata* sp. recorded in the "Appendix" of the present paper (B, Murayama's residence of Ôhirota).

and Horikoshi, 1966; Horikoshi, 1967). Although both species have a very similar outline of head, they are easily separable from each other by the presence of many dorsal papillae in *Phagocata papillifera*. Anatomically, *Phagocata papillifera* has a wide and rather long common ovovitelline duct (cf. Ijima and Kaburaki, 1916, p. 162, woodcut 15; Kaburaki, 1922, p. 20, text-fig. 7) which is slightly similar to the expanded common ovovitelline duct of the present new species. This anatomical feature is, however, unique in the present new species. It seems that this organ may serve a secondary function as vagina.

The present new species, *Phagocata suginoi*, differs from the other members of the genus in a combination of the following characters: living animals small in size (6 to 8 mm in length), delicate, and slightly colored whitish gray to pale grayish brown above, almost white below; head subtruncated with slightly projecting but rounded antero-lateral corner; having two very small eyes situated close together and without pigment-free ocular area around each eye; marginal adhesive zone well-developed; middle-sized, numerous dorso-ventral testes lie in two to three rows on either side and extend close to the posterior end; penis bulb middle-sized and weakly muscular with rather wide bulbar cavity into which sperm ducts enter separately from the antero-dorsal side (spermiducal vesicle well-developed); symmetrical penis papilla long and cylindrically shaped; wide ejaculatory duct separated from the bulbar cavity by an isthmus opens at the tip of the penis papilla (with a

protuberance on the roof of the duct); common ovovitelline duct entering the roof of the male genital antrum forms a long, expanded, thick-walled cavity lined with a highly glandular epithelium; copulatory bursa moderately large and of an elongated oval shape; bursa stalk long, slender, but the terminal part expanded and opening into the genital pore; common genital antrum non-existent.

Ecology and laboratory observations. The type-locality of *Phagocata suginoi*, the present new species, is a spring fed by a small quantity of underground water. The spring in a pit or a small cavity in the shadowy ground (ca. 40 cm in diameter). The water is about 10 centimeters deep. The bottom is muddy with dead leaves, the surface from which the planarians were collected. The water temperature is about 5°C and pH is 6.6 (January 23, 1973). The animals are rather few in number at the type-locality. They could not be obtained during the summer of 1973 because the spring was almost dried up.

It was observed in the laboratory culture that the animal moves by gliding only but not rapidly, although they may attach themselves to other objects more strongly than other epigeal *Phagocata* species. Crawling movement have not been observed in *Phagocata suginoi*.

According to the observation made by Murayama, *Phagocata suginoi* regenerates when the animal is cut into two pieces.

Note added in proof. Since this paper was submitted for publication Murayama observed the cocoon of *Phagocata suginoi*. In his culture, about 30 specimens laid a total number of 21 cocoons on April 26, 1974. The cocoon is spherical in shape (0.7–1.1mm in diameter). The hatching of cocoons occurred within about 30 to 40 days after deposition.

APPENDIX

Only two specimens of a small, low-pigmented, eyeless triclad were collected by Murayama, on October 20, 1969. The locality is an old unused well at Murayama's residence of Ōhirotā, Kashiwazaki (see map of Fig. 7). These specimens were sectioned by Kawakatsu and proved not to be in a sexually mature state (Kawakatsu's Specimen Lot No. 738 a, b). It is highly probable that this triclad is identical with *Phagocata suginoi*. Both localities belong to the same water system (the Sabaishi River drainage). Many sexually immature specimens of *Phagocata vivida* (Ijima et Kaburaki) also occurred in the Ōhirotā locality.

ACKNOWLEDGEMENT

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REFERENCES

- Ball, I. R., 1969. *Canad. J. Zool.*, **47**: 59.
- Dahm, A. G., 1949. *Lunds Univers. Årsskr. N. F.*, **45**, *Kungl. Fysiograf. Sällsk. Handl. N. F.*, **60**: 1.
- 1964. *Arkiv Zool.*, (2), **16**: 481.
- De Beauchamp, P., 1958. *Kungl. Fysiograf. Sällsk. I Lund Förhandl.*, **28**: 9.
- Horikoshi, I., 1966. *Collect. & Breed., Tokyo*, **28**: 126. (In Japanese.)
- Hyman, L. H., 1937. *Trans. Amer. micros. Soc.*, **56**: 298.
- 1951. *Ibid.*, **70**: 154.
- Ichikawa, A., and M. Kawakatsu, 1962 a. *Annot. zool. Japon.*, **35**: 29.
- and ——— 1962 b. *Ibid.*, **35**: 38.
- and ——— 1962 c. *Ibid.*, **35**: 112.
- and ——— 1963. *Ibid.*, **36**: 102.
- Ijima, I., and T. Kaburaki, 1916. *Annot. zool. Japon.*, **9**: 153.
- Kaburaki, T., 1922. *J. Coll. Sci. Imp. Univ. Tokyo*, **44**: 1.
- Kawakatsu, M., 1965. *Hydrobiologia*, **26**: 349.
- 1966. *Bull. biogeogr. Soc. Japan*, **24**: 9. (In Japanese.)
- 1967. *Bull. Fuji Women's College*, (5): 117.
- 1968 a. *Proc. U. S. Natn. Mus.*, **124** (3638): 1.
- 1968 b. *Collect. & Breed., Tokyo*, **30**: 40. (In Japanese.)
- 1968 c. *Jap. Soc. Syst. Zool. Circular*, (38-41): 11. (In Japanese, with English summary.)
- 1969. *Bull. Fuji Women's College*, (II), (7): 45.
- 1973. *The Nature & Animals (Tokyo)*, **3** (5): 9, (6): 11, (7): 8, (8): 7. (In Japanese.)
- 1974. In N. W. Riser and M. P. Morse, *Libbie H. Hyman Memorial Volume—Biology of the Turbellaria*: 291. McGraw-Hill Book. Co., New York, etc.
- and I. Horikoshi, 1966. *The Heredity (Tokyo)*, **20** (10): 13. (In Japanese.)
- and S. Iwaki, 1967. *Jap. J. Ecol.*, **17**: 214.
- Kenk, R., 1930. *Zool. Anz.*, **89**: 145, 289.
- 1953. *Proc. U. S. Natn. Mus.*, **103** (3322): 163.
- 1970 a. *Proc. biol. Soc. Washington*, **83** (2): 13.
- 1970 b. *Smithsonian Contrib. Zool.*, (80): 1.
- 1972. *Freshwater Planarians (Turbellaria) of North America. Biota of Freshwater Ecosystems Ident. Manual* (1). x+81 pp. U. S. Environm. Protect. Agency, U. S. Govern. Print. Office, Washington, D. C.
- Livanow, N. A., and Z. I. Zabusova, 1940. *Trudy Obshch. Estestvoisp.*, **56**, *Kazan Gosud. Univ.*, **83**: 83. (In Russian, with French summary.)
- Okugawa, K. I., 1939. *Annot. zool. Japon.*, **18**: 155. Japanese translation: In T. Kawamura, *Reports of the Limnological Survey of Kwantung and Manchoukuo*: 437. Kyoto.
- 1953. *Bull. Kyoto Gakugei Univ.*, (B), (3): 20.
- 1956. *Ibid.*, (B), (8): 19.